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FUNDAMENTALS OF SOVIET RAILROAD OPERATION

I. IMPORTANCE OF RAILROAD TRANSPORTATION IN THE USSR AND ITS DEVELOPMENT

Railroad transport is the basic means of transportation in the USSR. In 1940, it constituted 86 percent of all Soviet transport. By 1 January 1946 the total operated trackage of the entire Soviet network was 112,868 kilometers. The network included 7,450 freight-handling stations and about 1,000 depots.

Freight loading increased fourfold from 1918 to 1926, i.e., from 6,200 to 25,000 cars per day, while freight runs increased fivefold, i.e., from 14.1 to 73.5 billion ton-kilometers.

The First Five-Year Plan (1928 - 1932) saw the following developments: locomotive-park capacity increased 43 percent; 80,000 new cars were produced, including more than 40,000 large freight cars; 8,000 kilometers of station track were laid; 15 large railroad bridges were built; and 6,500 kilometers of new railroads were constructed. Freight transport and passenger transport increased 79 percent each in comparison with 1928.

However, transport indexes for 1934 failed to surpass those of 1933 and some were even lower. As a result, a number of far-reaching measures were carried out to improve transport; radical reorganization in the administrative agencies of railroad transport, strengthening of the principle of one-man leadership on all levels, and introduction of a code of discipline among the workers. At the end of the Second Five-Year Plan, the average loading of freight cars was 88,000 cars a day, or 172 percent of the 1933 figure. In 1938, 1,177,500 passengers, or 127 percent of the 1933 figure, were carried.

During the Second Five-Year Plan new powerful series FD, SO, and IS locomotives were produced, a complete transfer to automatic brakes took place (1935), and more than 200 repair stations were established.

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Altogether, in the course of the Five-Year Plans, 13,412 kilometers of railroad lines and 9,100 kilometers of second tracks were constructed. and 11,852 steam locomotives and 284,134 freight cars were added to the transport system.

In 1940, average daily loading was 98,000 cars; and in the first half of 1941, 107,000 cars.

During World War II, the entire railroad network in the west was cut off and only four lines were left open for communication with the country's arsenals in the Urals and Siberia; of these, only one was a double-track line. The single-track Krasnovodsk-Tashkent line was the only means of supplying fuel to the front and the country's industries.

The railroads successfully evacuated rolling stock and other equipment; only an insignificant number of cars and engines fell to the enemy. However, a great blow had been dealt to the transport system through the destruction of 65,000 kilometers of railroad lines, 13,000 bridges, 41,000 stations, 317 locomotives depots, and 2,500 station buildings.

In the first year of the Postwar Five-Year Plan, the railroads fully carried out their transport assignments: average daily carloadings in 1946 exceeded those of 1945 by 7,630 cars, and car turnaround time decreased by 0.85 day.

The following lines were constructed during World War II: Kizlyar-Astrakhan', which is a main line between the Caucasus and Central Russia; Samtrediya-Sukhumi-Sochi-Tuapse-Armavir line; and Stalingrad-Saratov-Syzran'-Kindyakovka (Ul'yanovsk)-Sviyazhsk line.

Large-scale construction is under way in the Urals. In addition to the South Siberian line, there are the following lines: Sos'va-Alapayevsk, Ishimbayevo-Yermolayevo, Urussu-Naryshevo, and Magnitogorsk-Baymak.

II. BASIC INFORMATION ON USSR RAILROADS

A. Transportation Work

The work of the railroad transportation system is measured by the quantity of freight and passengers transported and the total number of ton-kilometers and passenger-kilometers. The table below shows the growth of railroad transport in the USSR:

<u>Indexes</u>	<u>1913</u>	<u>1932</u>	<u>1937</u>	<u>1940</u>	<u>1950 (plan)</u>
Average daily carloadings, in thousands of cars	27.4	51.4	89.8	97.8	115.0
Originating traffic, in millions of tons	132.4	267.9	516.7	592.6	777.0
Freight turnover, in billions of ton-km	65.7	169.3	354.8	415.0	532.0
Passenger traffic, in millions of persons	184.8	967.1	1,142.7	1,343.5	1,350.0
Passenger turnover, in billions of pass-km	25.2	83.8	90.9	98.0	98.0

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B. Railroad Stations

The station is the basic unit of production in railroad transportation. In 1946, the total number of stations and sidings was 11,389. The importance of the station in operational work is evident from the following: in 1946, the length of station trackage was 47,504 kilometers, or more than 40 percent of the entire trackage operated in the network; up to 300,000 cars are handled daily on the network's stations; 300,000 workers service these stations.

C. Rolling Stock

The basic type of Soviet locomotive is the steam locomotive, although electric and gasoline locomotives are also used. Currently the locomotives have the following coefficients of useful performance: steam, 6-8 percent; electric, 14-15 percent; gasoline, 24 percent.

The most powerful steam freight locomotive at present is the Series FD locomotive, having a load of 20-21 tons on coupled axle, which permits it to run on Type II-A rails when the rails have 1,800 cross ties per kilometer. Its designed speed of 85 kilometers per hour is high for a freight locomotive. It is equipped with an automatic stoker.

The Series SO locomotive has a load of 17.5 tons per axle, designed speed of 75 kilometers per hour, and a 2-10-0 wheel arrangement. Because of the comparatively small axle load, this engine can be used on all Soviet lines without reconstructing the lines.

Prior to the construction of the new FD and SO types, the Series E (E^u , E^m , E^g , E^{sh} , etc.) locomotive was the basic model of steam locomotive. It has an 0-10-0 wheel arrangement, a designed speed of 65 kilometers per hour, and a load per axle of up to 17 tons.

During World War II, Series Ye (Decapod) locomotives were added to the steam locomotive park. Construction of Series L locomotives has been begun. The remaining types of steam freight locomotives (Shch, R, etc.) are no longer widely used on the USSR network.

The basic types of switching locomotives are the series O (O^o , O^d , O^v , O^p) locomotives, which have a designed speed of 50 kilometers per hour, an axle load of 13 tons, and an 0-8-0 wheel arrangement.

The table below gives basic data on the principal types of steam locomotives:

	<u>FD</u>	<u>SO</u>	<u>E^u</u>	<u>Ye^a</u>	<u>L</u>
Wheel arrangement	2-10-2	2-10-0	0-10-0	2-10-0	2-10-0
Designed speed, in km/hr	85	75	65	75	80
Weight on drivers, in tons	103.0	87.0	83.0	87.3	91
Water capacity of tender, in thousands of kg	44	23	23	28	28
Coal capacity of tender, in tons	18	15	8	13	18
Rated weight (locomotive and tender), in tons	235	145	125	150	185

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The basic type of electric locomotive is the VL-22 locomotive. During the new Five-Year Plan production of new eight-axle electric locomotives is planned. The specifications of these types of locomotives are as follows:

	<u>8-Axle Electric Locomotive</u>	<u>VL-22 Electric Locomotive</u>
Wheel arrangement	2-4+4-2 or 4-8+8-4	0-6+6-0
Designed speed, in km/hr	100-110	85
Speed on ruling grade (skorost' na rukovodyashchem pod'yeme), in km/hr	43-45	32.5-37.5
Hour rating of motors, in kw	500-550	350-400
Tractive force on ruling grade (sila tyagi na rukovodyashchem pod'yeme)	3.52	2.77
Weight on axle, in tons	22-23	22

In 1946 - 1950, a sharp increase in the length of roads serviced by Diesel locomotives is expected. A number of important railroad lines are to be changed over to this type of traction, including the Krasnovodsk-Ziadin-Arys' and the Gudermes-Astrakhan'-Krasnyy Kut. The table below gives the main specifications of this type of locomotive.

	<u>E^{1c}</u>	<u>VM Twin Engine</u>	<u>A</u>	<u>D^b</u>
Wheel arrangement	4-10-2	4-8-2+2-8-4	0-6-0+0-6-0	0-6-0+0-0-0
Length between buffers, in mm	15,710	27,202	17,150	17,890
Total weight, in tons	138	2 x 122.8	122	122.6
Coupled weight, in tons	98	2 x 79.9	122	122.6
Weight on driving axle, in tons	19.6	19.725	20.3	20.4
Designed speed, in km/hr	60	72	96	80
Wheel diameter, in mm	1,220	1,220	1,016	1,016

The basic types of freight cars are boxcars, flatcars, gondola and hopper cars, tank cars, and refrigerator cars. The growth in the proportion of freight cars equipped with automatic brakes and automatic couplers is shown in the following table:

	<u>1 Jan 1938</u>	<u>1 Jan 1939</u>	<u>1 Jan 1940</u>	<u>1950 (plan)</u>
Percent of cars equipped with automatic brakes (of total number of physical units)	49.7	60.1	68.4	93.0
Percent of cars equipped with automatic couplers (of total number of physical units)	17.2	23.8	31.2	75.0

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Specifications of Basic Types of Freight Cars in USSR

<u>Type of Cars</u>	<u>No of Axles</u>	<u>Capacity (in tons)</u>	<u>Light Weight (in tons)</u>	<u>Tare Coefficient</u>	<u>Length Over Buffers (in meters)</u>	<u>Full Capacity of Body (in cu m)</u>	<u>Volume (in cu m per ton of capacity)</u>	<u>Load on Axle (in tons)</u>
1. Large-capacity box car, USSR construction 1936 - 1941, with automatic brake (without hand brake) 4	4	50	21.9	0.44	14.73	89.8	1.80	18.0
2. Same, with automatic and hand brakes 4	4	50	22.79	0.45	15.35	89.8	1.80	18.13
3. Two-axle box car, USSR construction with automatic brake 2	2	20	11.4	0.57	7.85	45.4	2.27	15.65
4. Same, with automatic and hand brakes 2	2	20	12.1	0.60	8.54	45.4	2.27	16.05
5. Earlier standard type of two-axle box car without hand brake 2	2	16.5	8.2	0.50	7.63	39	2.36	13.1
6. Same, with hand brake 2	2	16.5	8.6	0.52	8.24	39	2.36	13.3
7. Large-capacity flatcar 4	4	60	22	0.37	14.9	--	--	20.55
8. Large-capacity flatcar 4	4	50	18.4	0.37	14.22	--	--	17.1
9. Two-axle, high-sided flatcar 2	2	20	9.2	0.46	10.42	--	--	14.6
10. Earlier standard type of two-axle high-sided flatcar, without hand brake 2	2	16.5	7.3	0.44	10.39	--	--	12.65
11. Same, with hand brake 2	2	16.5	7.8	0.47	10.39	--	--	12.9
12. Gondola car 4	4	60	22.7	0.38	13.92	66.8	1.11	20.67
13. Hopper car, 1932 - 1933 construction 4	4	50	21.0	0.42	10.03	59.34	1.19	17.75
14. American half-car 4	4	50	22.28	0.45	13.54	46.93	0.94	18.05

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Table Continued

<u>Type of Cars</u>	<u>No of Axes</u>	<u>Capacity (in tons)</u>	<u>Light Weight (in tons)</u>	<u>Tare Coeffi- cient</u>	<u>Length Over Buf- fers (in meters)</u>	<u>Full Cap- acity of Body (in cu m)</u>	<u>Volume (in cu m per ton of capacity)</u>	<u>Load on Axle (in tons)</u>
15. Large-capacity petroleum tank car with automatic brake (without hand brake)	4	50	21.8	0.44	12.02	50	1.00	18.5
16. Same, with automatic and hand brakes	4	50	22.5	0.45	12.22	50	1.00	18.65
17. Two-axle tank car, new construction without hand brake	2	25	11.0	0.44	8.78	25	1.00	18.0
18. Same, with hand brake	2	25	11.7	0.47	8.96	25	1.00	18.35
19. Earlier standard type of two-axle tank car with hand brake	2	15.9	8.1	0.51	7.63	--	--	12.0
20. Large-capacity refrigerator car, with perforated bunkers and without hand brake	4	28.5	30.0	1.05	13.32	84.3	2.96	14.63
21. Same, with tank-type bunkers	4	28.5	30.0	1.05	13.32	84.3	2.96	14.63
22. Two-axle refrigerator car, 1932 construction, with perforated bunkers and without hand brake	2	19	18.0	0.95	10.39	59.5	5.28	18.5
23. Same, with hand brake	2	19	18.4	0.97	10.39	63.75	4.93	18.7

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III. ORGANIZATIONAL STRUCTURE OF THE RAILROAD ADMINISTRATION

A. Division of Railroad Network Into Okrugs and Systems

The establishment in 1945 - 1946 of the railroad okrugs permitted closer contact between the higher administrative transport agencies and the lower subdivisions while retaining a single, centralized administration of the railroad carrier. The okrugs are administrative, economic, technical, and planning organizations. They have under their jurisdiction locomotive and car repair plants, construction materials plants, quarries, and other transport enterprises. Each okrug is headed by a chief, who manages it through administrations and departments. The operations administration has charge of traffic, freight operations, and passenger transport. In addition, the okrug has a communications administration, locomotive administration, railroad car administration, and track administration.

The railroad system (doroga) is a complete independent economic and administrative unit. It is headed by a chief who manages the system through services and departments which conduct the corresponding branches of the railroad management. The basic services of a system are: (1) traffic, (2) locomotive, (3) railroad car, (4) track, (5) communications and signals, (6) freight, and (7) passenger.

B. Railroad Divisions

The railroad divisions were organized in 1946. Their main task is to coordinate the activities of the various services. The absence of these divisions had led to frequent delays during disputes of authority among various service chiefs, because there was no single chief who could make an overruling decision. Wartime experience proved that the unification of all services under a single leadership was a great advantage.

C. Traffic Services

The management of railroad transport is exercised by the Central Traffic Administration of the Ministry of Transportation, by the okrug operations administrations, and by the railroad system traffic services.

The technical railroad equipment, i.e., locomotives, cars, trackside and station installations, communications, and centralized traffic control, are controlled by the traffic service. This union of functions, i.e., the management of transport and operation of the basic technical equipment, makes this service all-important and, in a sense, the service incorporates and executes the work of all the other services. Here, more than in any other service, success depends on the quality of the personnel.

The traffic service is charged with:

1. Organization of traffic and the work in stations; working out train schedules and their implementation; supervision over the planning of train formation; technical operation of the stations; drawing up instructions and control over their implementation.
2. Drafting monthly operational plans for the work of the railroad systems in accordance with the state plan, including loading and unloading quotas; transfer of empty cars to other systems; planning the amount of traffic at system junction points; planning the size of the locomotive and car parks required; car turnaround time norms, etc.
3. Devising and executing measures for fulfilling the state plan.

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4. Operational planning and control of station and traffic division operations, and, in the case of an okrug operations administration, also operational planning and control of railroad system operations in regard to loading, unloading, delivery of empty cars, making up trains, and train movement.

5. Selection, training, and assigning of workers such as switchmen, yardmen, dispatchers, station masters, etc.

6. Proper maintenance of traffic equipment such as switches and signals, station and service buildings, track and communication installations in stations.

7. Drawing up plans for the construction of second tracks, stations and junctions, centralized switch and signal control projects, and mechanized hump yards, with the aim of increasing traffic capacity.

The Central Traffic Administration of the Ministry of Transportation includes:

- a. Chief dispatcher-inspectors for the okrug systems.
- b. Operational departments, charged with the regulation of rolling stock and the hauling of the more important types of freight (military, liquid, and coal).
- c. Technical departments, charged with problems of technical planning, regulation of car flow, organization of traffic and work in the stations, traffic capacity, and capital construction.

The operations administration of an okrug has the following departments:

- a. Operations and management department, charged with the supervision of the systems' operations.
- b. Technical department, charged with technical planning, plans for the formation of trains, analysis of technological processes in the stations, issuing train schedules, traffic capacity, and capital construction.
- c. Transport planning department.
- d. Department for assorted loading and unloading.
- e. Commercial operations department.
- f. Passenger transport department.

The traffic service of a system has two basic departments:

- a. Management department, which effects uninterrupted operational control over the work of the railroad system. Direct control over the work of the traffic division is carried out by assistant chiefs on duty and line dispatchers.
- b. Technical department, charged with compiling train schedules, plans for train formations, technical plans for the system's operation, technological processes in the stations, and the solution of capital construction problems.

In the traffic division, the operational management of train movements and loading is effected by the senior dispatcher and the alternating duty officers of the department who coordinate the work of train dispatchers, and the section train dispatchers (in accordance with the number of circuit-sections in the division).

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D. Freight and Passenger Services

The freight service has charge of:

1. Planning railroad transport and routing.
2. Economic studies of areas adjacent to the railroad system.
3. Guidance and control over the implementation of transport plans with respect to destinations and types of freight.
4. Questions of railroad tariffs.
5. Regulation of reciprocal relations between the railroad system and customers, other media of transport, and other railroad systems.
6. Organization and mechanization of loading and unloading operations.
7. Organization of the storage and weighing facilities of the railroad systems.
8. Safe handling of lading

The passenger service is charged with:

1. Compilation of passenger train schedules and control over their implementation.
2. Development and implementation of measures for the organization and improvement of passenger transport.
3. Organization of large-scale passenger transport (excursions, tours, etc.).
4. Insuring proper maintenance of station buildings and other passenger installations in stations.
5. Organization of the operation of city stations, city ticket offices, service bureaus, etc.
6. Supervision of repair of passenger cars and locomotives.
7. Distribution of the passenger-car park in accordance with train schedules.
8. Supervision over the safety of passenger traffic.
9. Study of passenger traffic flow.
10. Plans for capital investments for passenger traffic service.

IV. BASIC PRINCIPLES OF TRAFFIC ORGANIZATION OF USSR RAILROADS

A. General Principles

Traffic organization must insure the following:

1. Fulfillment of the state plan for transport
2. Best utilization of the railroads' operating facilities, i.e., locomotives, cars, and traffic capacity, highest labor productivity, and lowest cost of transport

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3. Safety in traffic

4. Prompt delivery of freight, with minimum expenditures for carrying.

B. Organization of Car Flow

For maximum train speeds and reduction of the time for handling cars in stations, cars must be grouped into trains according to their route and destination. The scheme for making up freight trains is as follows:

1. According to the distance to be traveled without reprocessing; in this respect trains fall into the following categories:

a. Long-haul trains, which pass, without reprocessing, through at least one marshaling yard, and travel at least 500 kilometers

b. Through trains, which pass, without reprocessing, through at least one section junction station

c. Section trains, which run, without reprocessing, from one section junction station or marshaling station to the next

d. Local trains, which consist of cars consigned to intermediate stations of the section

2. In accordance with their destination, they are:

a. Single destination trains consisting of cars having the same destination

b. Multiple-destination trains, consisting of cars having two or more destinations and grouped accordingly

The most perfect method of organizing car flow is to fix the cars' destination at the point where they are loaded. This is especially important in Soviet transportation since more than 70 percent of the entire freight turnover consists of eight basic bulk freights: coal, ore, timber, metals, construction materials, grain, petroleum, and wood.

C. Basic Operational Indexes

The basic indexes employed in railroad transport show both the quality of traffic organization and the utilization of rolling stock; they are:

1. Fulfillment of train schedules and plans for making up trains

2. Train speeds: average speed including stops, average speed excluding stops, and average daily speed including stops

3. Time spent in processing trains and cars in stations

4. Utilization of load capacity (ton-kilometers per car-axle-kilometer and tons of freight dispatched, received, or transferred to another system per car dispatched, received, or transferred to another system)

5. Car turnaround time and average daily distance traveled by cars

6. Completion of the schedule for locomotive turnaround time and locomotive average daily distance traveled.

7. Fulfillment of the established train weight norms.

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Average speed excluding stops is the average speed of a train along a section, excluding time spent in stops in intermediate stations.

Average speed including stops is the average speed of a train along a section, including time spent in stops in intermediate stations.

Average daily speed including stops is the average daily speed of a train from the station where it is made up or where it enters a railroad system or division to the station where it is broken up or delivered to another railroad system or division, including time spent in stops at all intermediate stations.

The quality of station operation is determined by the indexes showing the expenditures of time for processing a train in transit, a transit car requiring rehandling, and a local car (a car which completes freight operations such as loading, unloading, or sorting small shipments in the station).

Freight-car turnaround time is the basic index for the quality of utilization of freight cars and determines the quality of the organization of all elements of the carrying process. Freight-car turnaround time is the time from the moment a car is loaded to the moment of the next loading. It is made up of the following elements:

1. The time the car spends in the loading station
2. The time the car spends traveling in trains from the loading station to the unloading station
3. The time spent in handling the car in marshaling stations or section junction stations along the route
4. The time the car spends in the unloading station
5. The time the car spends traveling empty to a new loading station (in cases where the car is not loaded in the station where it is unloaded). Freight-car utilization is also measured by average daily distance traveled. Average daily distance traveled of a car measures its average daily speed during the whole turnaround time period.

The operational turnaround time of a locomotive is the time spent by the locomotive in movement from the station of the base depot to the station of the turnaround depot and back again, including the time spent by the locomotive in the station of the turnaround depot and on the station (not depot) tracks of the station of the base depot.

Full locomotive turnaround time is equal to the operational turnaround time plus the time the locomotive spends on the depot tracks in the base depot.

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